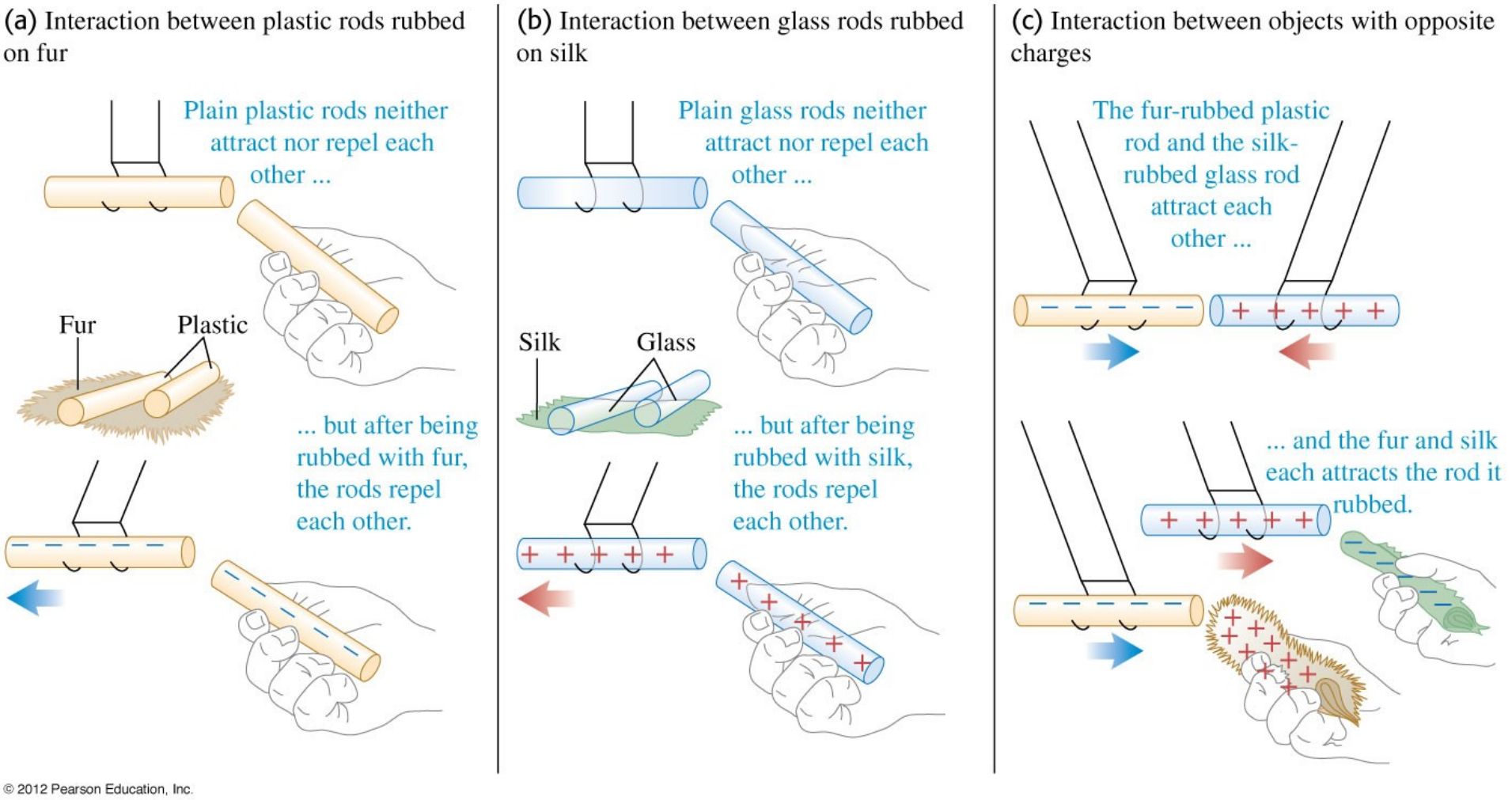
Fundamental Interactions

Interaction	Particles	Relative Strength	Range
Gravitational always attractive holds planets in their orbits around Sun	any massive particle	$\sim 10^{-38}$	long
Electromagnetic attractive/repulsive fundamental in optics, chemistry, biology; source of friction	electrically charged	$\sim 10^{-2}$	long
Weak necessary for buildup of heavy nuclei; responsible for radioactive decay (beta decay)	quarks, leptons	$\sim 10^{-6}$	short $\sim 10^{-18}$ m (0.1% of the diameter of the proton)
Strong holds protons and neutrons together in the nucleus	hadrons (protons, neutrons, mesons)	1	short $\sim 10^{-15}$ m (diameter of a medium sized nucleus)

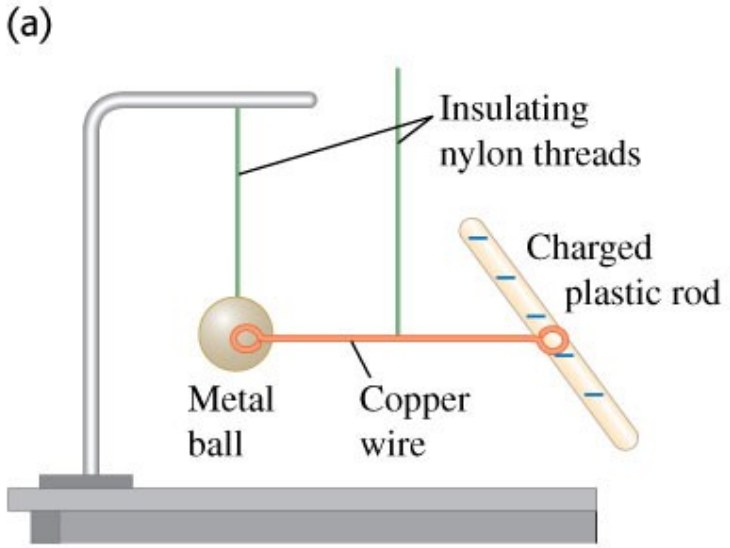
Electric Charge

FIG. 1

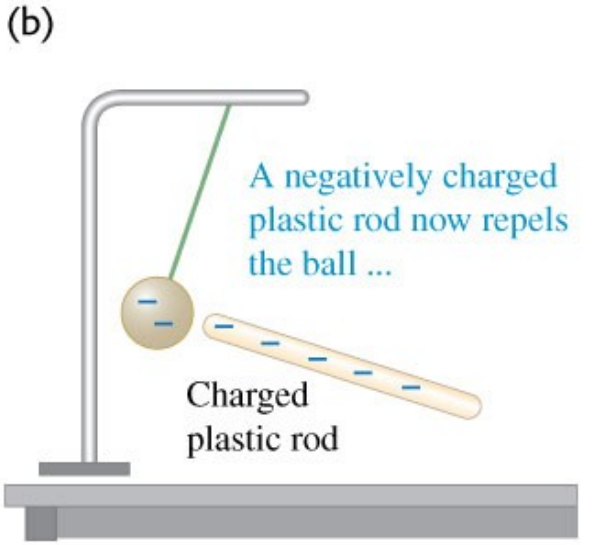


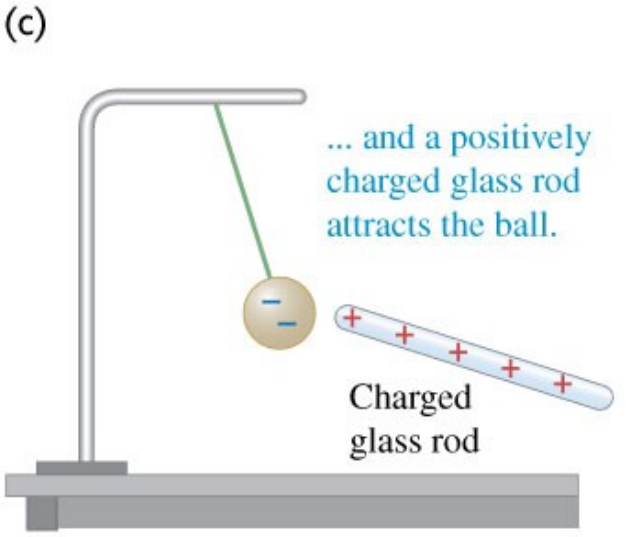
Conductors and Insulators

FIG. 2



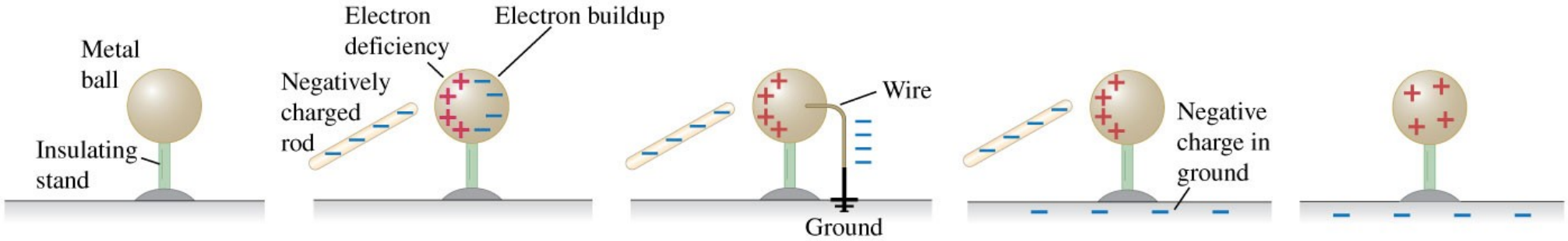
The wire conducts charge from the negatively charged plastic rod to the metal ball.





Induced Charges

FIG. 3



(a) Uncharged metal ball

(b) Negative charge on rod repels electrons, creating zones of negative and positive **induced charge**.

(c) Wire lets electron build-up (induced negative charge) flow into ground.

(d) Wire removed; ball now has only an electron-deficient region of positive charge.

(e) Rod removed; electrons rearrange themselves, ball has overall electron deficiency (net positive charge).

Coulomb's Measurement

FIG. 4

(a) A torsion balance of the type used by Coulomb to measure the electric force